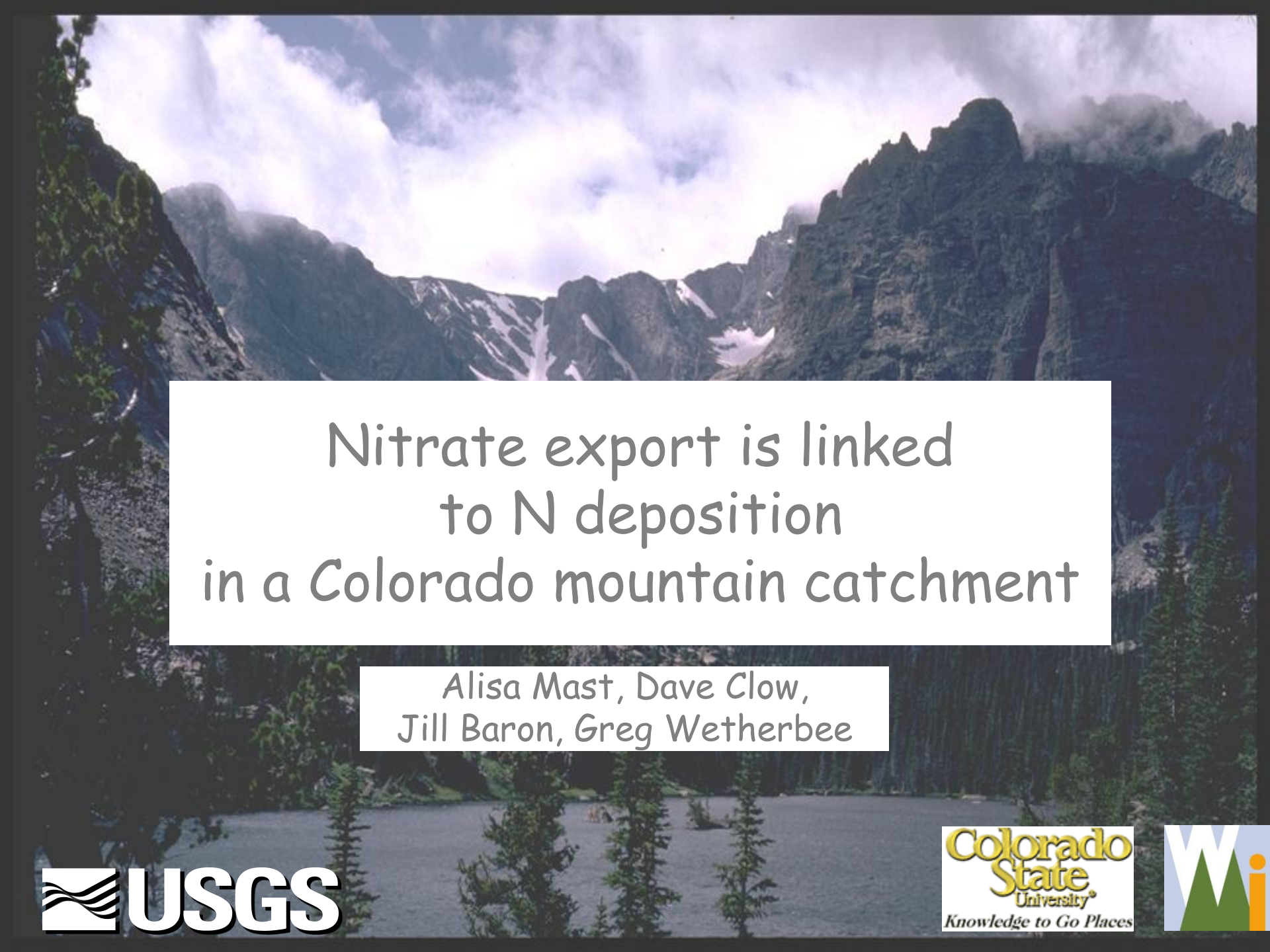

Nitrate export is linked to N deposition in a Colorado mountain catchment

Alisa Mast, Dave Clow,
Jill Baron, Greg Wetherbee

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Loch Vale Watershed

Loch Vale watershed

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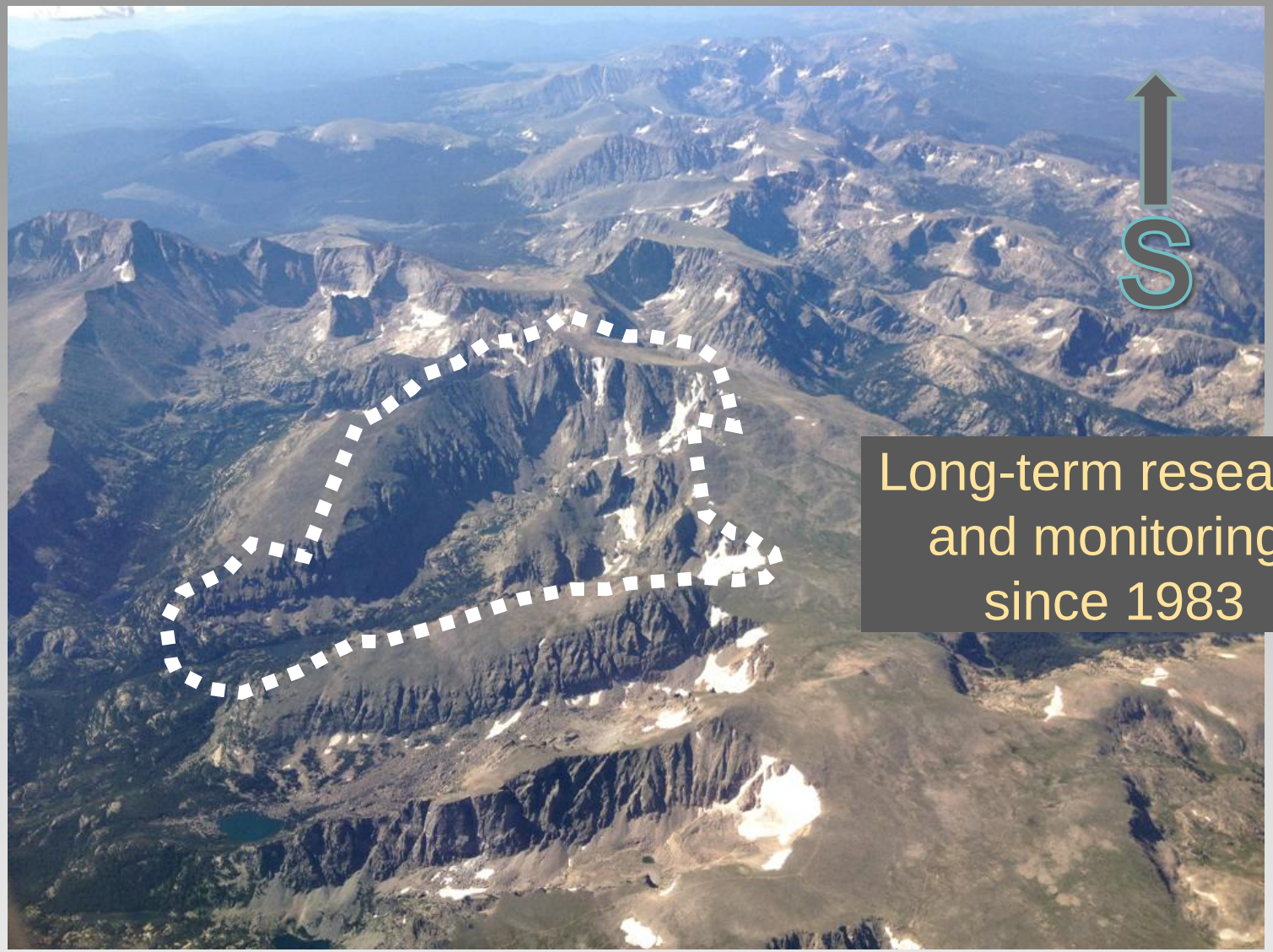
Loch Vale Watershed



Long-term research and monitoring since 1983

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Foundations

- 31 years of continuous monitoring
- Paleolimnology
- Experiments in field and lab to test cause and effect
- Modeling ecosystem processes and "what-if" scenarios
- Spatial comparisons in Colorado and across western US

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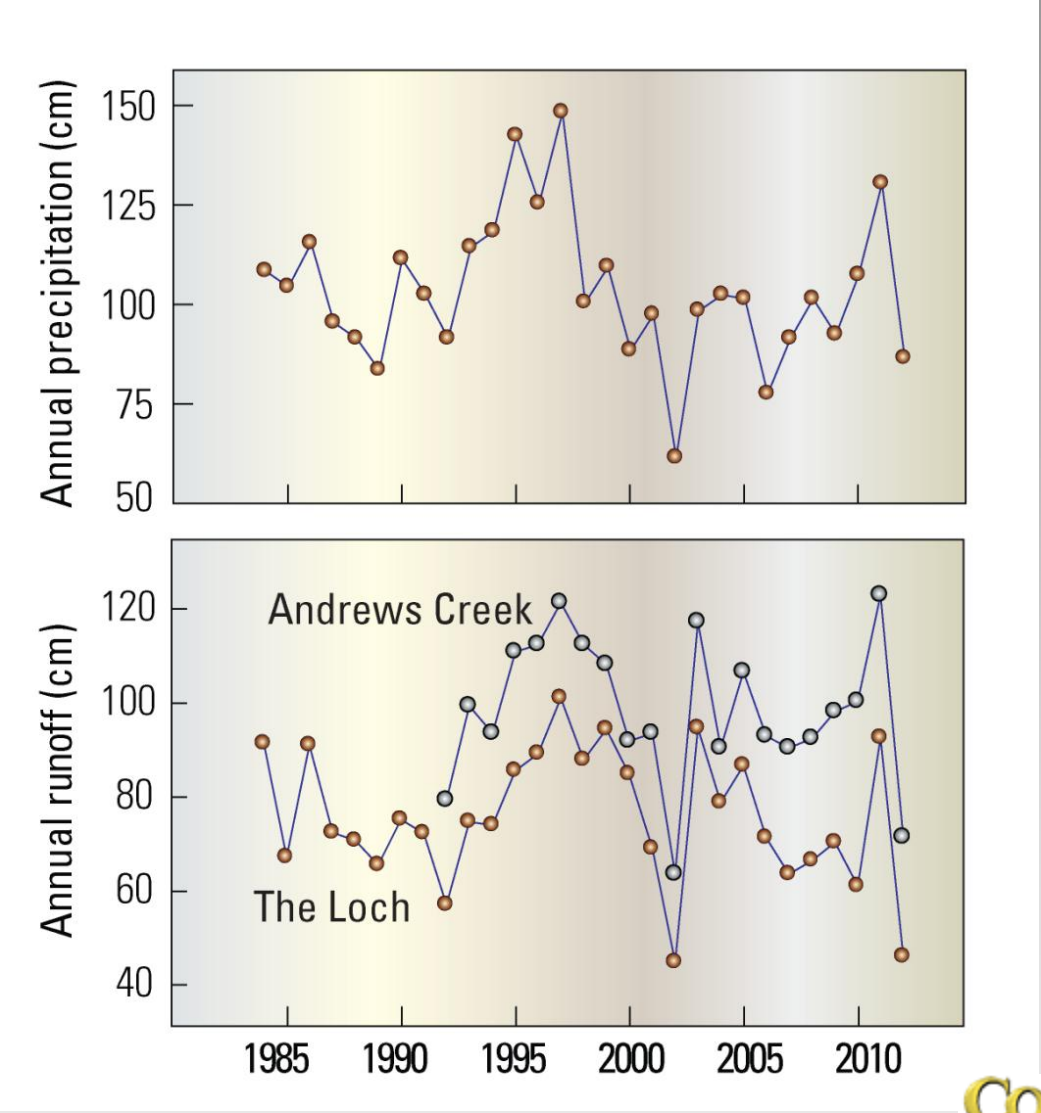
Annual runoff tracks precipitation



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But first! When data are taken at face value…

1984-2012	Bear Lake SNOTEL	Loch Vale NADP	Loch Outlet
Bear Lake SNOTEL	--	0.56	**0.6**
Loch Vale NADP	**0.56**	--	**0.29**
Lake Irene SNOTEL	**0.74**	0.48	0.53
Copeland SNOTEL	**0.71**	0.48	0.52
University Camp SNOTEL	**0.76**	0.54	0.57
Niwot SNOTEL	**0.66**	0.52	0.57
Niwot C1	**0.73**	0.5	0.42
Niwot D1	**0.62**	0.59	0.33

R^2 of annual precipitation amount

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Bear Lake SNOTEL had higher correlations with ANY site other than Loch Vale NADP

1984-2012	Bear Lake SNOTEL	Loch Vale NADP	Loch Outlet
Bear Lake SNOTEL	--	0.56	**0.6**
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R^2 of annual precipitation amount

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Even discharge at Loch Outlet compared poorly with Loch Vale NADP

1984-2012	Bear Lake SNOTEL	Loch Vale NADP	Loch Outlet
Bear Lake SNOTEL	--	0.56	**0.6**
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R^2 of annual precipitation amount

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We upgraded the Loch Vale precipitation gage from a Belfort to a Noah IV gage in 2007

which resulted in a step change in precipitation amount unmatched by nearby sites

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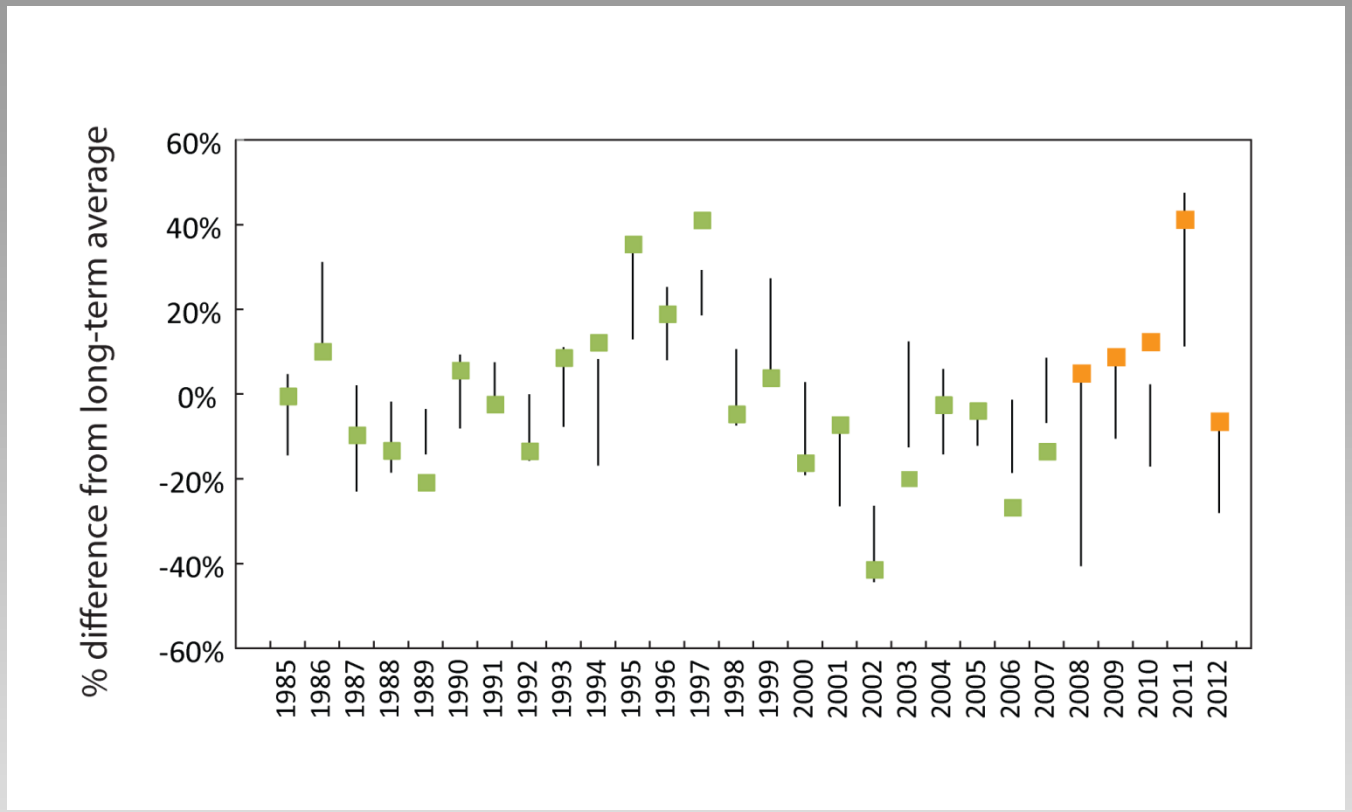
NOAH IV captures more pptn than Belfort and SNOTEL



Vertical lines:
range of annual pptn at
6 Front Range SNOTEL sites

: Loch Vale Belfort gage

: Loch Vale NOAH IV gage

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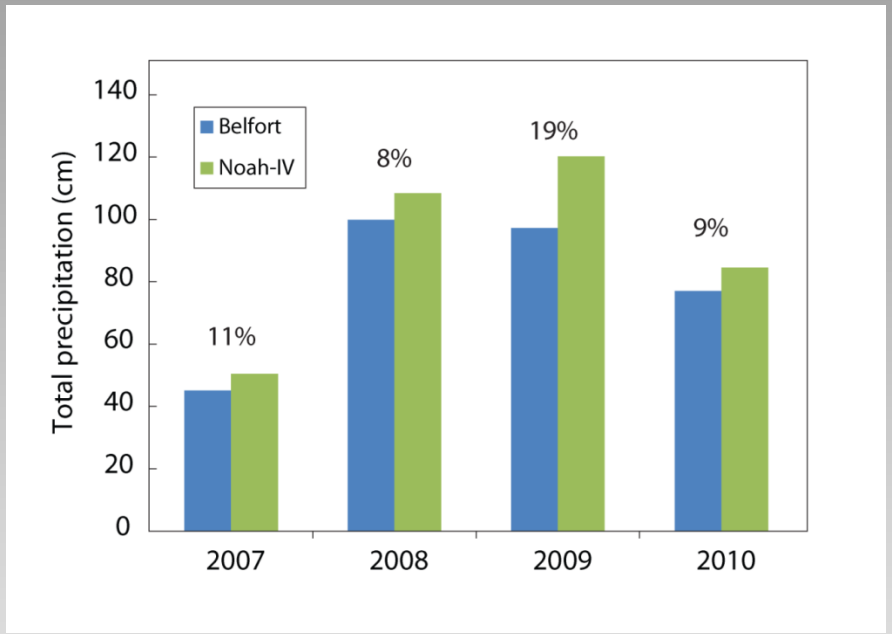
Four years of co-location of old and new gages allowed for a correction factor



%: increases in pptn
at Noah IV compared to Belfort

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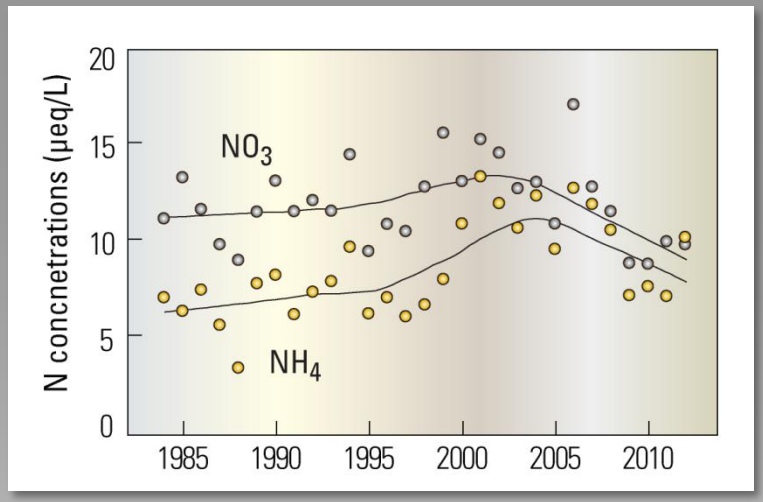
Results



$[NO_3^-]$ and $[NH_4^+]$ in Loch Vale NADP precipitation ⇧until ~2004

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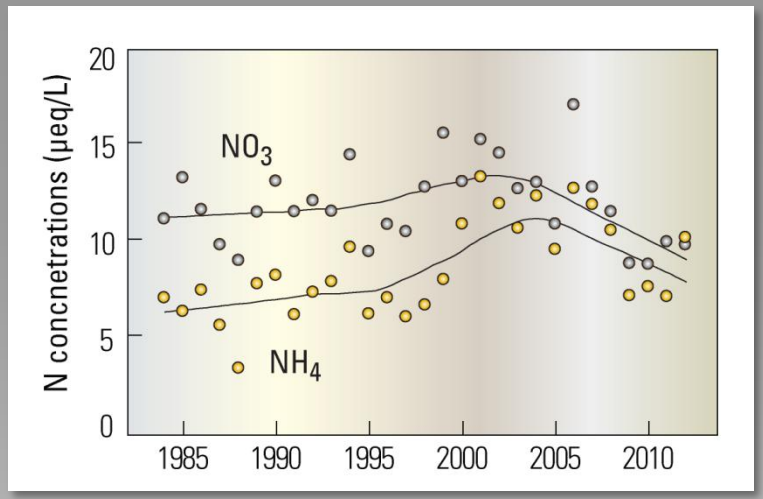
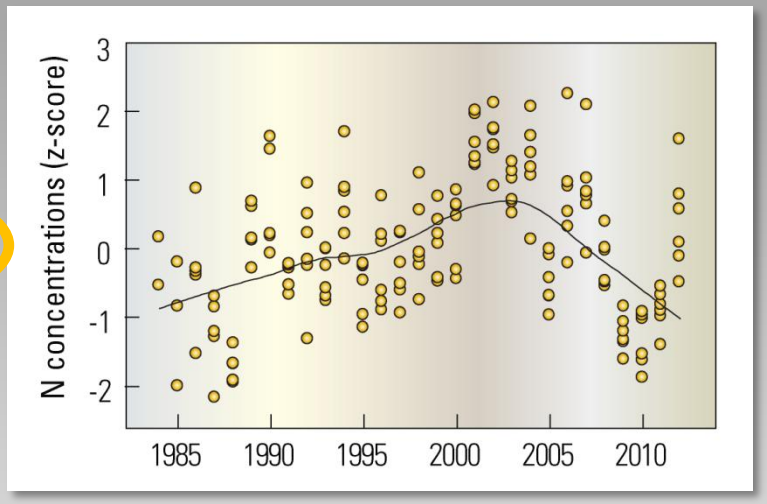
Results



$[NO_3^-]$ and $[NH_4^+]$ in Loch Vale NADP precipitation ⇧ until ~2004

Similar pattern from 6 other Front Range NADP sites



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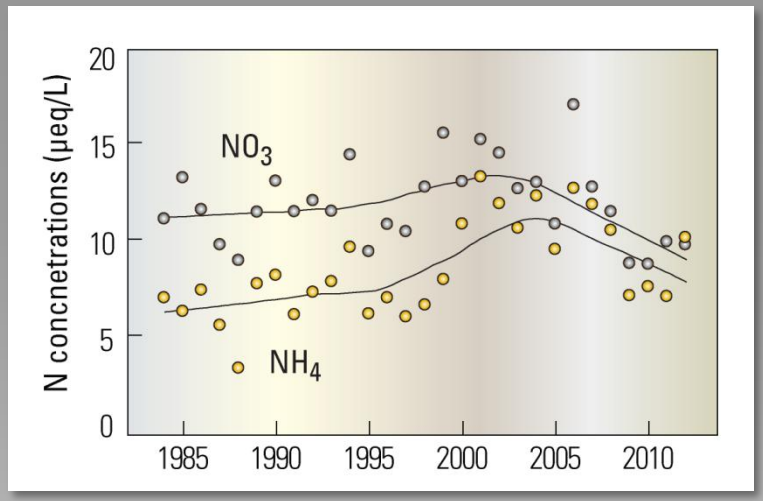
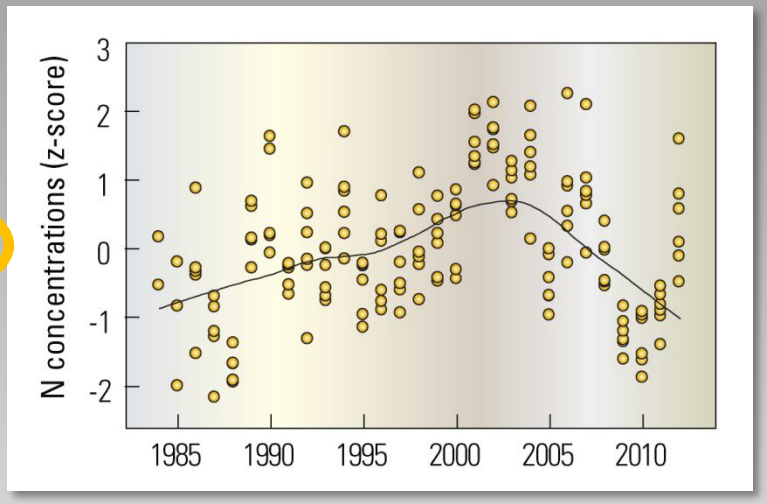
Results



$[NO_3^-]$ and $[NH_4^+]$ in Loch Vale NADP precipitation ↑ until ~2004



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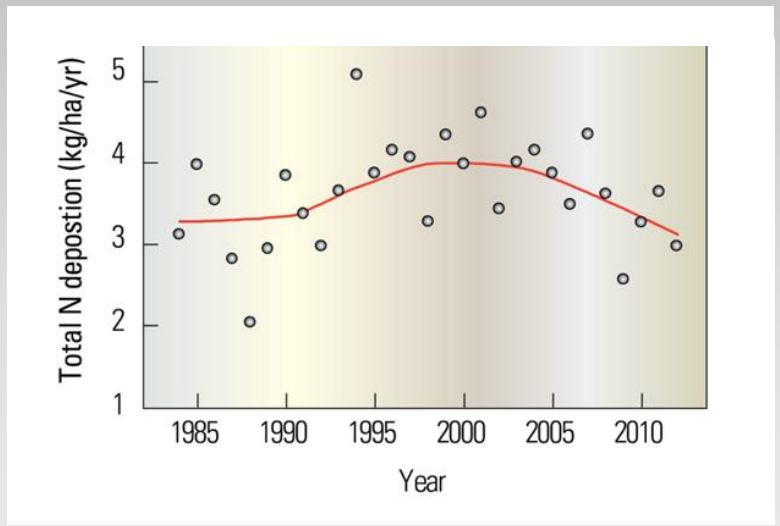

Total N (wet+dry) deposition: same pattern of ↑ and subsequent ↓

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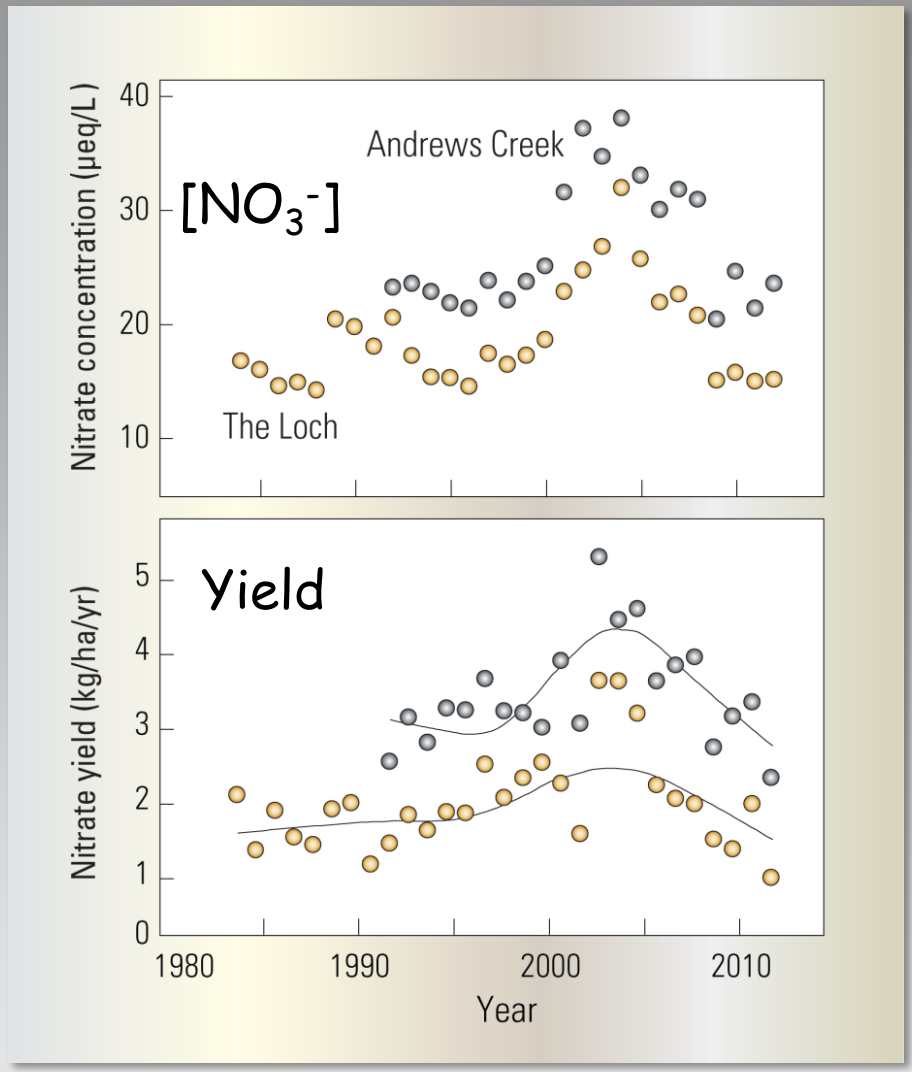
Results



Stream $[NO_3^-]$ and yield: same trends as precipitation

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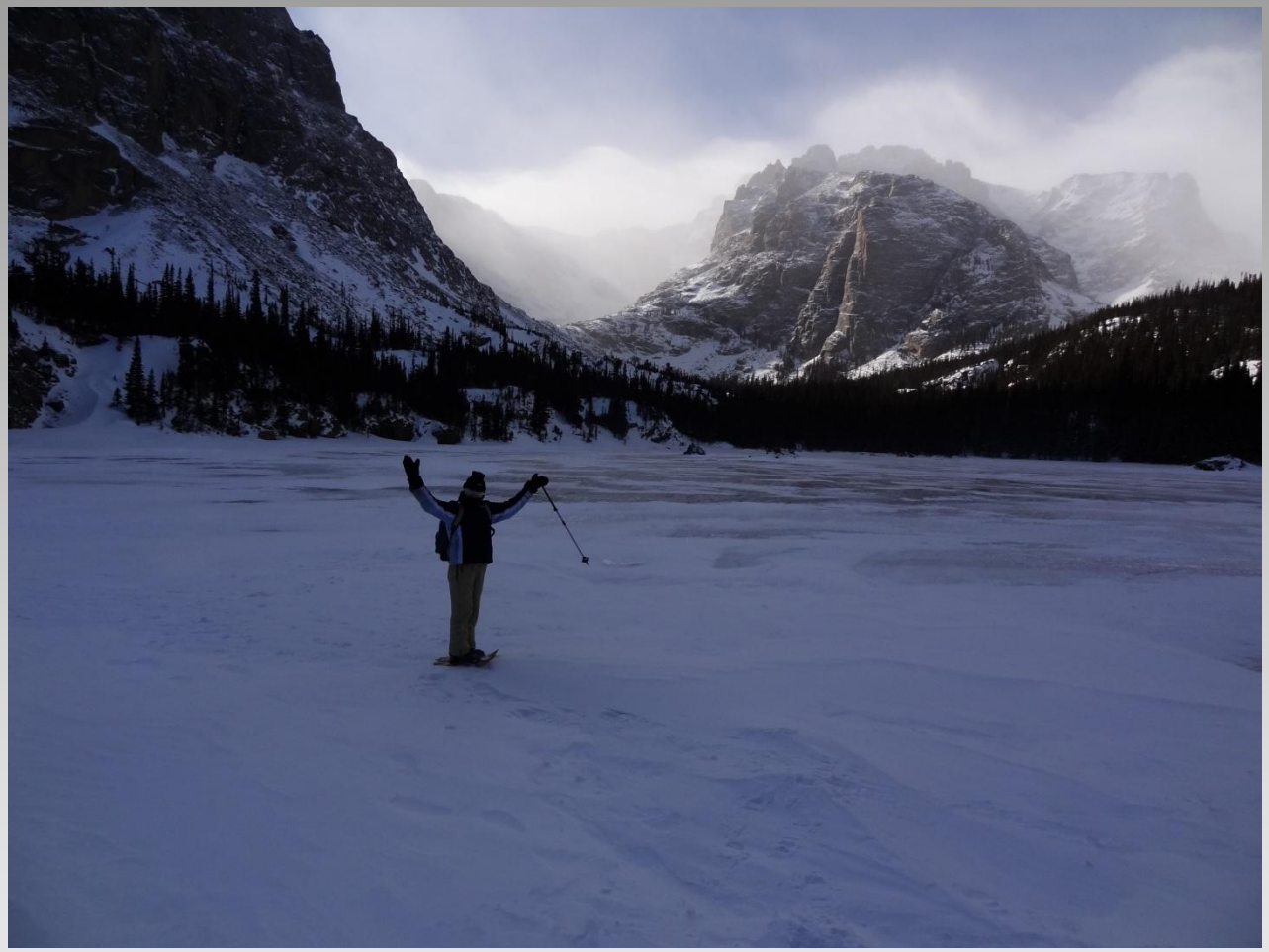
Why is there such a direct response?



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Why is there such a direct response?

USGS

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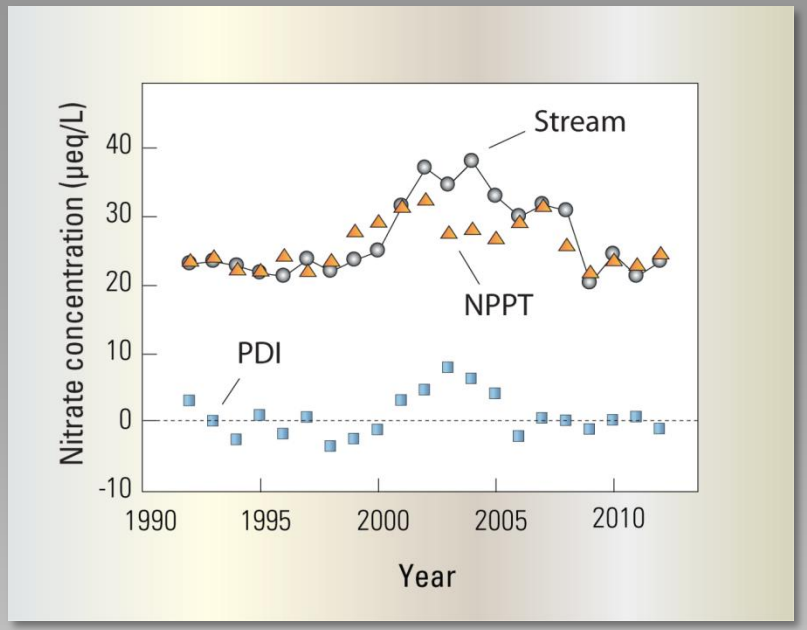
Results



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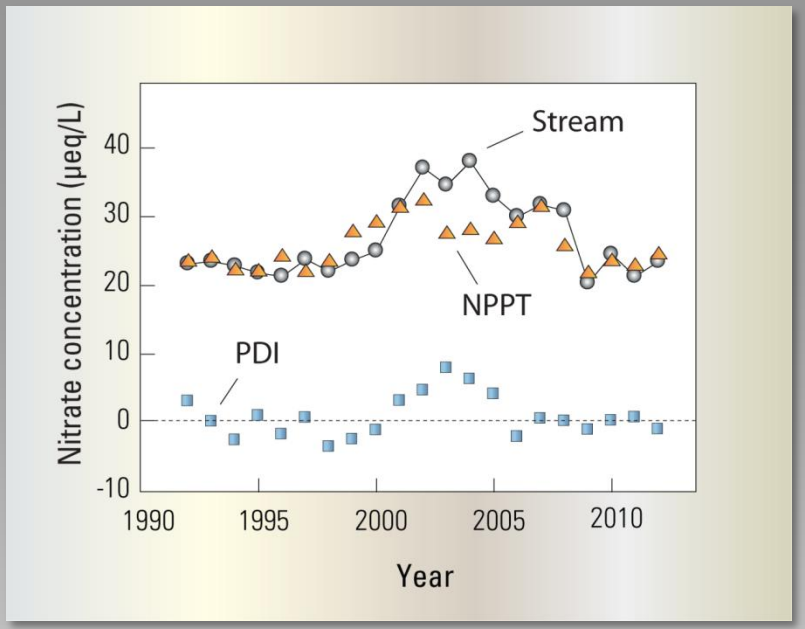
Results

83% variability at Andrews Cr. (73% at The Loch) explained by precipitation [N]+ PDI lagged 1 yr



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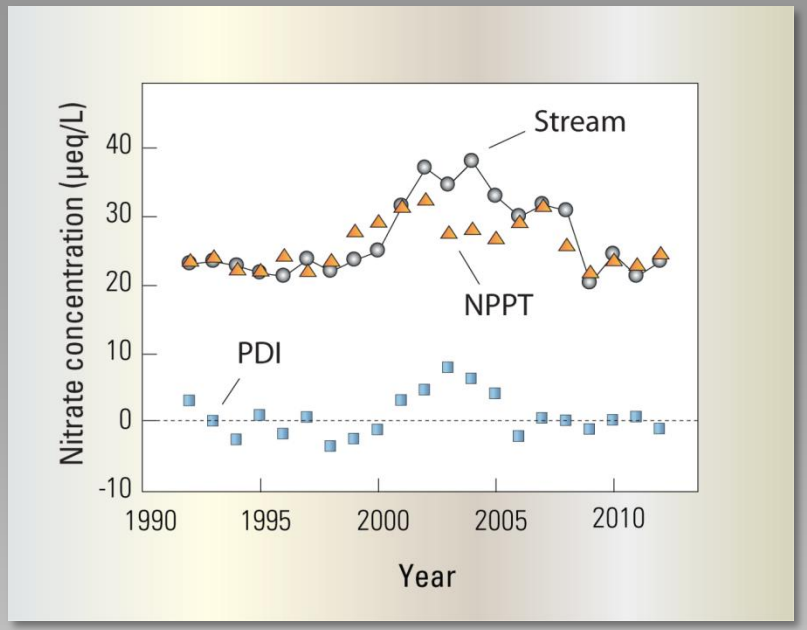

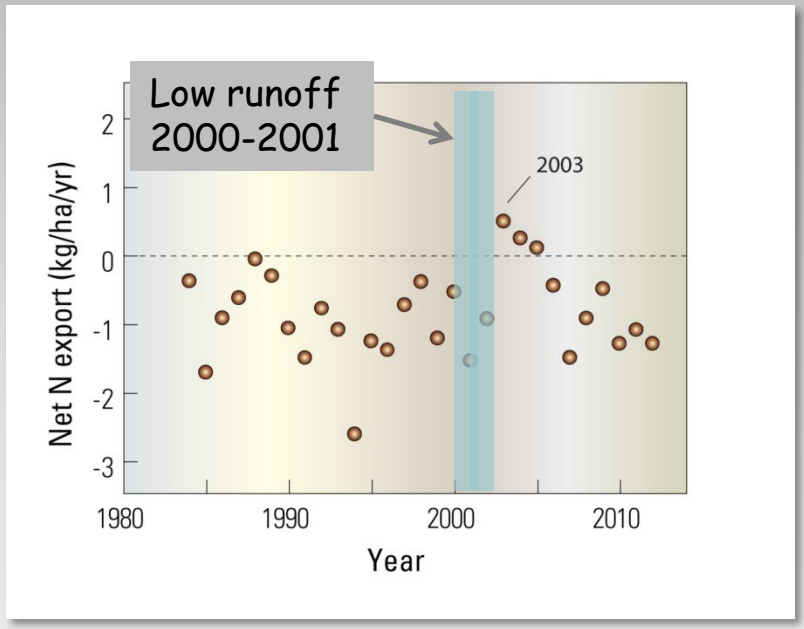

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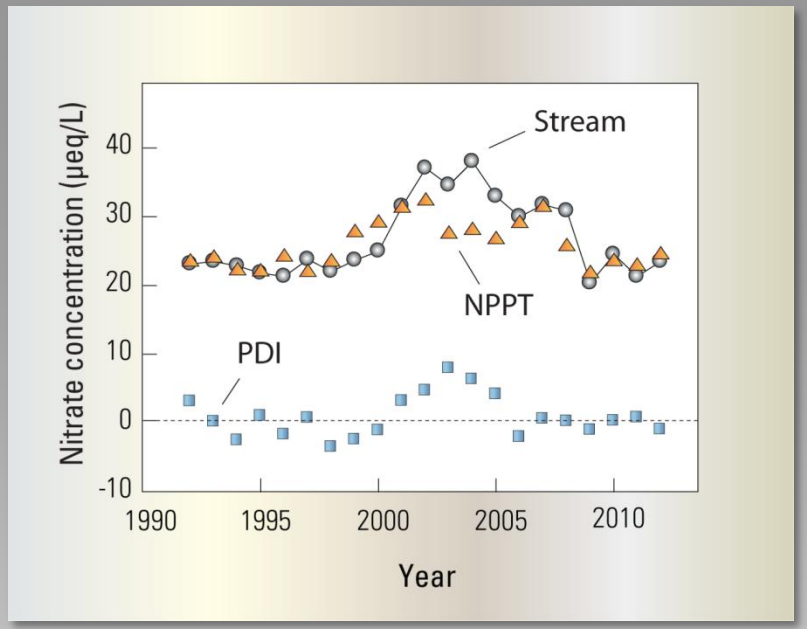

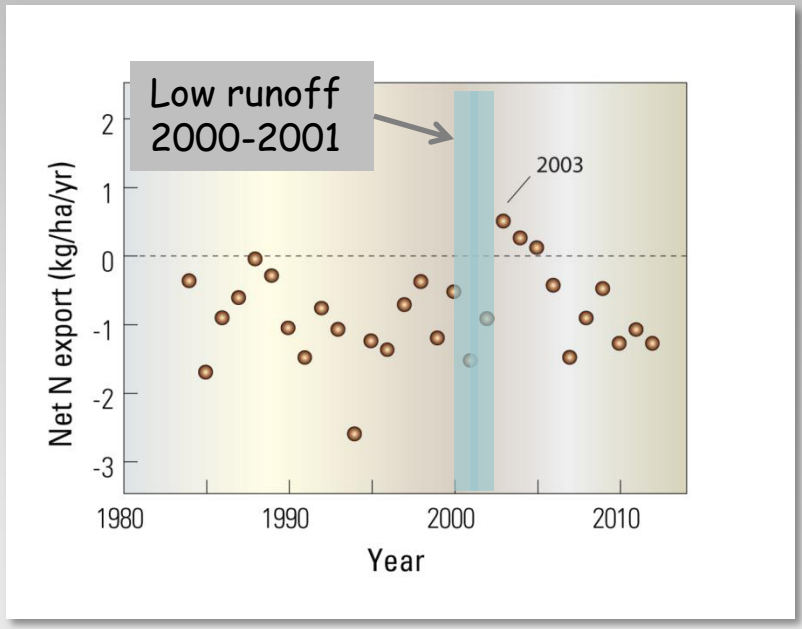

N accumulates in low runoff years, is flushed in normal/high years. And N accumulates in biomass

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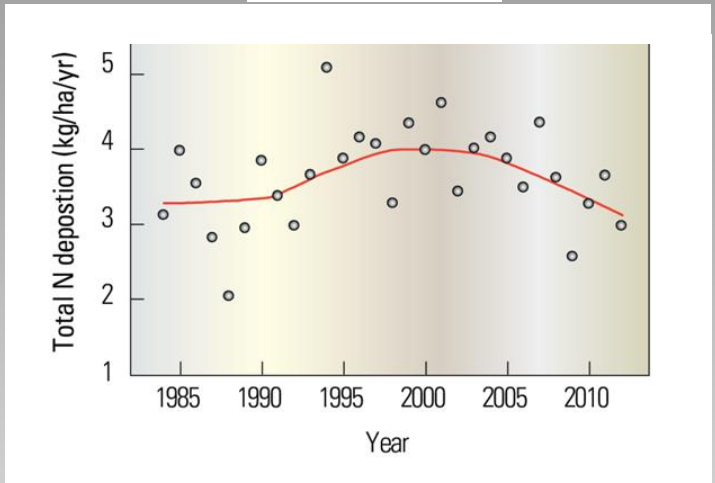
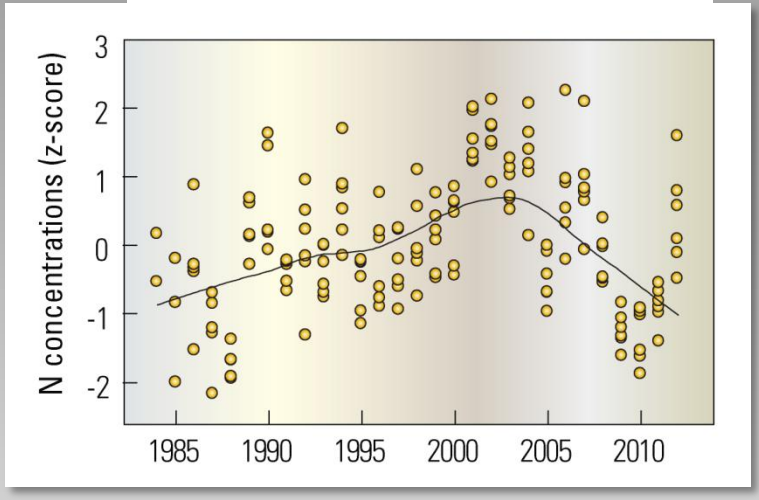
Discussion/Summary

What is causing ↓ N deposition ?

Loch Vale



Front Range NADP sites



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Discussion/Summary



Long-term monitoring essential for trend and pattern analysis

N deposition has been declining since ~2010

In high elevation Loch Vale stream N tracks deposition (with a lag due to drought)

Water quality is improving in real time in response to lower N emissions and deposition

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